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Weed control in growing corn

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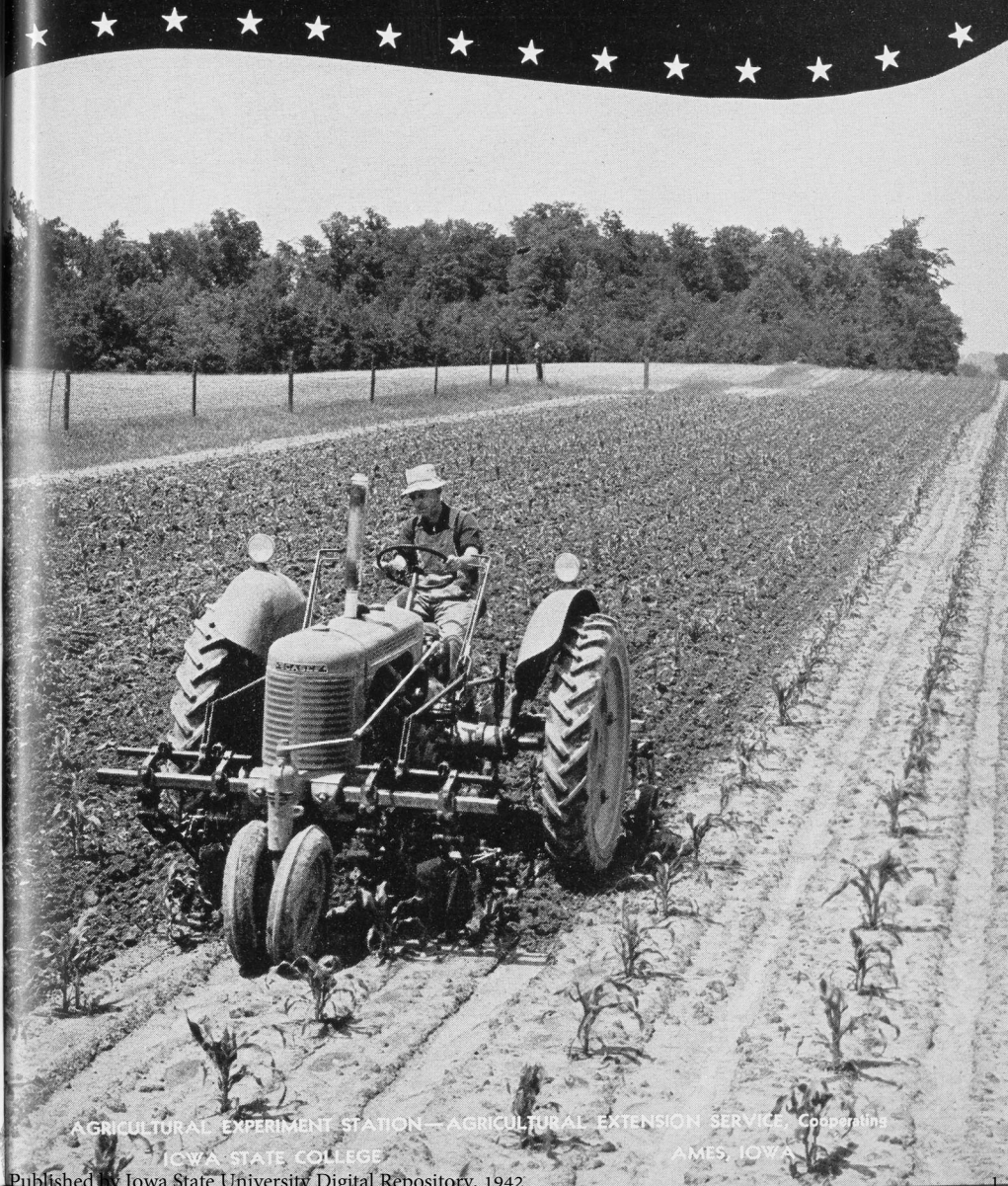
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WEED CONTROL IN GROWING CORN



AGRICULTURAL EXPERIMENT STATION—AGRICULTURAL EXTENSION SERVICE, Cooperating
IOWA STATE COLLEGE

AMES, IOWA

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CONTENTS

	Page
Summary	439
Introduction	441
Weed problems	441
Methods of controlling weeds.....	442
Weeds and corn.....	443
Effect of seedbed preparation on weed control.....	444
Primary preparation	444
Secondary preparation	445
Purposes of cultivation.....	446
How cultivators destroy weeds.....	447
Machines for early cultivation.....	448
Cultivator equipment	453
Cultivation of check-rowed corn.....	457
Cultivation of drill-planted corn.....	461
Cultivator speeds	467

SUMMARY

Weed control is becoming a more serious problem in Iowa from year to year.

General methods of combating weeds are outlined. Improved equipment such as described in this bulletin enables the careful farmer to improve the control of weeds in corn-fields.

Methods of seedbed preparation are described which assist in control of weeds without excessive input of labor or power.

The principal purpose of cultivation of corn is to control weeds, but early cultivation to control sand-blowing is also essential under some conditions.

Cultivators destroy weeds by three methods: (1) Uprooting the weed at seedling or later stage of growth; (2) smothering the aerial parts of the weed by covering with soil; and (3) severing the aerial parts from the root system.

For early cultivation of corn, the spring tooth weeder and the rotary hoe were effective in killing weed seedlings when the soil surface was lightly crusted by moderate rainfall, but they were not very effective when the soil was heavily crusted by intense rainfall nor when the soil surface was loose and dry.

The best cultivator equipment for use when corn plants were small consisted of six sweeps per row and rotary hoe shields. When first cultivation could be delayed until corn plants had grown about six leaves, it was found best to leave off the shields and use half sweeps next to the corn row.

The best equipment for second cultivation under usual conditions was one pair of disk hillers throwing soil into the corn row and two pairs of sweeps per row. Experimental scrapers on the disk hillers prevented coverage of corn plants.

For the last cultivation, the best cultivator equipment was the same as for second cultivation except that scrapers on the disks were not needed.

An experimental spring tooth weeder rear attachment for a tractor cultivator was effective in filling tractor wheel tracks,

leveling the soil between corn rows and improving weed control.

Three cultivating programs are suggested for check-rowed corn with a view of improving weed control and keeping labor and power input at a minimum.

Experiments showed that difficulties in controlling weeds in drill-planted corn can be overcome by use of the best-adapted cultivator equipment. Cultivating programs are suggested for drill-planted corn.

Speed of travel of cultivators should be such that the cultivating equipment will do the best possible job of destroying weeds, and this generally was observed to be between $2\frac{1}{2}$ and 4 miles per hour.

Weed Control in Growing Corn¹

BY CLAUDE K. SHEDD, EDGAR V. COLLINS AND J. BROWNLEE DAVIDSON

A study of machinery for growing and harvesting corn has been carried on at Ames, Iowa, since 1931 by the Agricultural Engineering Section, Iowa Agricultural Experiment Station, cooperating with the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture. Experiments were conducted on the Agricultural Engineering Research Farm at Ames. This farm comprises soils in the Webster and Clarion Series, and the topography is comparatively level. Maximum slopes are about 5 percent. The purpose of this bulletin is to report the results of these experiments insofar as they relate to the methods and machinery best adapted for controlling weeds in surface-planted corn.

Recent improvements in machinery enable the corn grower to produce his crop with less labor than was formerly required and to improve the control of weeds in cornfields. Machinery, labor and power for producing corn have been discussed in a previous publication.²

Improving weed control is the principal objective under consideration in the present bulletin.

WEED PROBLEMS

Observations by botanists indicate that weed control is becoming a more serious problem in Iowa from year to year. Porter and Sylwester³ state that: "The area of distribution of many perennial weeds has been rapidly increasing Unfortunately most of the serious perennial weeds described occur in areas where the land is best adapted by topography and fertility to permanent cropping. Continued use of these lands requires that careful consideration be given to the destruction of weeds and the prevention of their further spread."

¹ Project 396 of the Iowa Agricultural Experiment Station.

² Shedd, C. K., Davidson, J. B. and Collins, E. V. Machinery for growing corn. U. S. Dept. of Agr., Cir. 592. 1940.

³ Porter, R. H. and Sylwester, E. P. Noxious and other bad weeds of Iowa. Iowa Agr. Ext. Service, Cir. 201 (revised). 1939.

METHODS OF CONTROLLING WEEDS

Weed control in cornfields depends to a considerable extent upon the weed control measures taken in the previous cropping of these fields, including the production of crops other than corn. Some weeds can be destroyed while producing corn; other weeds can be destroyed to better advantage while producing other crops. Therefore, it seems worth-while to review the principal methods of combating weeds that may be followed in general farming operations.

1. **Tillage** of the soil destroys or retards weed growth by:
 - a. Covering weed seed to a depth that prevents immediate germination. Some will lose their viability before being again brought to the surface.
 - b. Uprooting the weed so the roots may dry.
 - c. Cutting the aerial parts of deep-rooted weeds from the root system.
 - d. Covering the aerial parts of the weed with soil.
 - e. Tillage to encourage or hasten germination of weed seeds and later tillage to destroy weed seedlings. This method may be of considerable importance for crops which may be planted late.
2. **Smother crops** destroy or retard weed growth by forming a dense crop growth that cuts off light as well as soil nutrients and moisture from weeds.
3. **Poisoning** by application of certain chemicals may destroy or retard weed growth.
4. **Prevent seeding.** Weeds which have escaped destruction may be prevented from producing seed by:
 - a. Mowing one or more times during the summer and fall.
 - b. Fall plowing before weed seeds have matured.
5. **Prevent weed seed distribution.** If weed seed has been produced, the following precautions may be taken against their distribution by animals or by machinery:
 - a. Plant crop seeds that are free from weed seed.
 - b. When pasturing weed-infested fields, do not allow the animals to run to fields that are not infested.
 - c. Manure produced from feed containing noxious weed

seed may be composted to destroy the seed before the manure is spread on fields.

d. Harvesting machines may be cleaned thoroughly to remove weed seed before the machines are moved from one field to another.

6. **Eternal vigilance** is an important factor in weed control. Sometimes an expensive infestation of such a weed as Canada thistle can be averted by a small amount of hand work to destroy the first weeds that appear.

WEEDS AND CORN

Spread of weeds may be increased by growing corn without special attention to weed control. On the other hand, the careful farmer has an opportunity when growing corn to reduce the population of many kinds of weeds. During cultivation operations he can detect the first appearance of any new weeds and destroy them, by hand work if necessary.

Corn may be grown in the final stages of ridding a field of some serious weeds such as European bindweed or creeping Jenny. After this weed has been fought with summer fallow, smother crops or chemical there will usually be scattered plants surviving the following year or, if seed has been produced, seedlings may appear for several years. By use of good cultivator equipment and a reasonable amount of hand work, including several inspections after the corn is laid by, the last of these weeds may be destroyed while producing corn.

With good methods and equipment it is usually possible to have such common annual weeds as foxtail and pigweed almost completely eliminated at the last cultivation, but it is seldom that a field of matured corn is completely free from weeds. Weeds left at the last cultivation compete with the corn and produce seed before the corn crop is mature. If rains are frequent enough to keep the surface soil moist during July, many annual weeds, including butter print, will sprout from seed after the corn is laid by and produce seed before frost. If cocklebur or butter print weeds are present, a few are likely to escape destruction by cultivation. Some of the labor

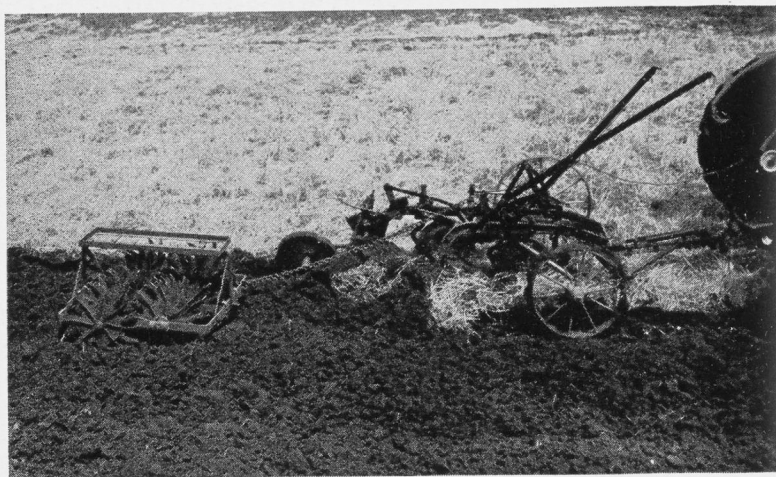


Fig. 1. For spring plowing it was found advantageous to use a section of rotary hoe attached to the plow. The pull chain was attached off center on the hoe frame, eliminating the need for a hitch bracket on the plow. When the rotary hoe was pulled backward, as shown, it had less tendency to pick up trash when turning around on headlands.

saved by using improved equipment may well be used to destroy serious weeds by hand work.

It is well to take precautions against spreading weed seed from one field to another. Weed seeds may lodge at various places on a corn binder or on a corn picker. If noxious weeds are present, it is good practice to clean harvesting machines thoroughly when leaving a field, especially if the machines are to be taken to another farm.

EFFECT OF SEEDBED PREPARATION ON WEED CONTROL

The success of any cultivating procedure depends to some extent on the preparation of the seedbed.

PRIMARY PREPARATION

Plowing is usually the primary operation in preparing a seedbed for surface planting. It covers crop residues and weeds and loosens the soil enough for aeration and easy penetration of planters and cultivators. A cloddy, rough surface from fall plowing tends to increase the winter absorption of

water from rain and snow and reduces wind erosion. Weathering action during the winter breaks down the clods and levels the surface to some extent. In case of spring plowing, weathering action cannot be depended upon to reduce clods; therefore it is desirable to till the plowed soil at the time of plowing or soon thereafter while the surface clods are still moist. This tillage breaks up surface clods and packs the soil to some extent, thus reducing the loss of moisture from the soil in case of dry weather.

For tillage at the time of spring plowing, it was found advantageous to attach a section of rotary hoe to the plow as shown in fig. 1. By attaching the pull chain off center on the rotary hoe frame and hitching directly to the plow, the rotary hoe wheels were given enough lead to guide them onto the plowed ground without the use of a hitch bracket extending to the side of the plow as would be required for pulling a section of spike tooth harrow. It was found best to pull the rotary hoe backward to reduce the tendency to pick up trash when turning on headlands.

SECONDARY PREPARATION

After initial preparation of the soil as explained above, the purposes of secondary tillage up to the time of planting are to kill weeds and to level off the irregularities in the soil surface.

A smooth surface permits planting at uniform depth in moist soil so seed will all germinate promptly and the corn plants will all be about the same size at the time of first cultivation.

It is desirable to kill as many weed seedlings as possible in the process of preparing the seedbed. It has been thought that early tillage may stimulate germination of weed seeds. It was observed at Ames, however, that weed growth usually did not appear in either fall plowed or spring plowed soil until about May 1 regardless of whether or not early tillage was given. For planting between May 10 and 15, a single tillage with tandem disk harrow and spike tooth harrow, fig. 2, just before planting was usually sufficient to destroy weed growth and level the soil surface. Additional tillage operations prior

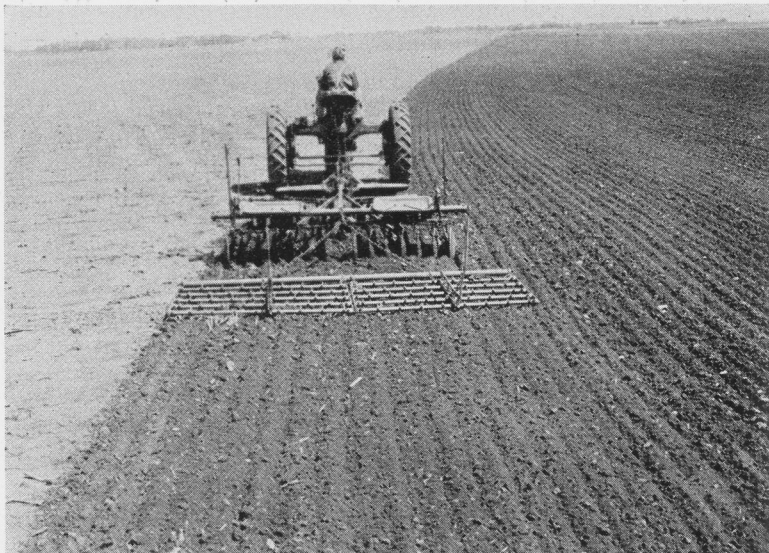


Fig. 2. For preparing a seedbed for corn, a tandem disk harrow and spike tooth harrow combination was found to be effective in destroying weeds, filling tractor wheel tracks and leveling off irregularities in the soil surface. For planting up to May 15, one tillage of either fall-plowed or spring-plowed ground with this combination just before planting was found to be sufficient preparation under ordinary conditions.

to that time produced no benefits in weed control nor as to germination and growth of the corn. But there must be sufficient tillage so that the soil will be free from growing weeds when the corn is planted. In case the soil is badly infested with weeds, it may be desirable to delay planting for a week or 10 days to permit additional seedbed tillage after the weeds are making more vigorous growth.

PURPOSES OF CULTIVATION

The principal purpose of cultivating corn is to control weeds. F. D. Richey⁴ summed up many years of work on corn cultivation by various experiment stations as follows: "The results of all the experiments considered as a whole indicate that cultivating as often and as deep as necessary to control weeds, and no more, is the desirable practice."

⁴ Richey, Frederick D. Corn culture. U. S. Dept. of Agr., Farmers' Bul. 1714.

Under some soil and weather conditions, however, cultivation is essential when the corn plants are small to prevent injury by blowing sand. It was found at Ames that cultivation with a weeder or a rotary hoe was sufficient for this purpose.

HOW CULTIVATORS DESTROY WEEDS

Cultivating machines kill weeds in three ways: (1) Uprooting the weed, that is removing the roots from their placement in the soil and exposing them to drying conditions; (2) smothering the aerial parts of the plant by covering with soil; and (3) severing the aerial parts from the root system of deep-rooted weeds.

In the space between corn rows these methods may be applied vigorously at each cultivation, hence there is little difficulty in controlling weeds in this space. It is more difficult to destroy weeds in the row, but they may be uprooted at the seedling stage of growth by use of a harrow, a weeder or a rotary hoe. These machines scratch or dig the surface



Fig. 3. Early cultivation of corn was done quickly and with low input of labor and power by use of a spring tooth weeder in six-row width. This machine is effective in killing weed seedlings when the soil surface is lightly crusted by moderate rainfall.



Fig. 4. About the same results were obtained by use of a rotary hoe as by use of the spring tooth weeder shown in fig. 3.

enough to uproot weed seedlings but not enough to permanently injure the corn plants. In later cultivations the only method employed to kill weeds in the drilled corn row or in the hill of check-rowed corn is to cover them with soil.

MACHINES FOR EARLY CULTIVATION

Experiments to measure the value of a spring tooth weeder (fig. 3), a rotary hoe (fig. 4), a spike tooth harrow and a sweep cultivator (fig. 6) for early cultivation of corn were carried on from 1934 to 1941. Results were measured by yields of corn, by stand counts at harvest time and by observations of weed control.

Yield results obtained in these experiments are recorded in table 1. The yields recorded are averages of replicated plots (five or more replications). Statistical analysis showed that differences in yield obtained by use of the different machines were highly significant in experiments 3 and 4 in 1935, experiment

TABLE 1. YIELDS OF CORN OBTAINED WITH USE OF DIFFERENT MACHINES FOR EARLY CULTIVATION.
(Note: After the cultivations listed in the table all plots were given two cultivations.)

Method	Machine used	Yields, bu. per acre																			
		1934		1935		1936				1937		1938		1939		1940			1941		
		1	2	3**	4**	5	6	7	8	9*	10**	11	12	13**	14	15	16	17**	18	19	
a	Spring tooth weeder, once												67.3					53.9	60.6	65.4	
b	Spring tooth weeder, twice	21.0	22.1	42.1	40.2	32.0	28.0	33.1	31.7	81.1	60.1	65.9	70.6	65.7	78.6	73.7	76.2	55.4	60.6	62.6	
c	Rotary hoe, twice	21.7	22.8	38.4	38.5	31.0	30.2	35.1	32.3	80.1	60.2	65.1	70.0								
d	Spike tooth harrow, twice	22.5	22.8	37.8	38.2	31.6	29.5	35.0	33.4	77.6	56.2	65.0	69.0								
e	Sweep cultivator, once	21.2	22.6	46.2	45.9	31.6	27.5	34.2	33.6	79.1	61.0	67.0	72.0	71.3	78.3	74.5	76.8	55.9	61.2	66.4	
f	No early cultivation	23.7	23.2	34.7	34.0	31.1	27.7	34.4	33.7	78.8	58.5	66.6	70.1		78.8			45.0	62.3	62.9	

*Significant differences in yield.

**Highly significant differences in yield.

Conditions of Experiments—

1. Fall plowed. Previous crop oats-sweet clover. Level surface planted May 15.
2. Fall plowed. Previous crop oats-sweet clover. Furrow openers used on planter May 15.
3. Spring plowed. Previous crop corn. Level surface planted May 11.
4. Spring plowed. Previous crop corn. Furrow openers used on planter May 11.
5. Spring plowed. Previous crop corn. Level surface planted May 15.
6. Spring plowed. Previous crop corn. Furrow openers used on planter May 15.
7. Fall plowed. Previous crop oats. Level surface planted May 19.
8. Fall plowed. Previous crop oats. Furrow openers used on planter May 19.
9. Fall plowed. Previous crop oats-clover. Level surface planted May 11.
10. Spring plowed. Previous crop corn. Level surface planted May 13.
11. Fall plowed. Previous crop corn. Level surface planted May 12.
12. Spring plowed. Previous crop oats-clover. Level surface planted May 23.
13. Spring plowed. Previous crop corn. Level surface planted May 23.
14. Spring plowed. Previous crop oats-clover. Level surface planted May 23.
15. Fall plowed. Previous crop sweet clover. Level surface planted May 8.
16. Fall plowed. Previous crop sweet clover. Level surface planted May 20.
17. Spring plowed. Previous crop corn. Level surface planted May 26.
18. Spring plowed. Previous crop oats-clover. Level surface planted May 8.
19. Spring plowed. Previous crop oats-clover. Level surface planted May 28.

10 in 1937, experiment 13 in 1939 and experiment 17 in 1941. Differences in experiment 9 in 1937 were significant. In all other experiments the yield differences were not large enough to be significant, that is they indicate no difference in the value of cultivation performed by the different machines and no reduction in yield due to omitting early cultivation, method "f."

Weed-control observations made at harvest time indicated that in most of these experiments weeds were equally well controlled by all of the methods under comparison. The exceptions were in experiments 3 and 4 in 1935 and in experiment 17 in 1941, when wet weather prevented later cultivation at the proper time. In these three experiments the best weed control was by method "e" (three cultivations) and the poorest weed control by method "f" in which early cultivation was omitted.

The results of this study may be stated as follows:

Omitting early cultivation (method "f") resulted in lower yields of corn and less effective control of weeds than obtained by three cultivations (method "e") only when excessive rains prevented later cultivation at the proper time. This occurred in experiments 3 and 4 in 1935 and in experiment 17 with late-

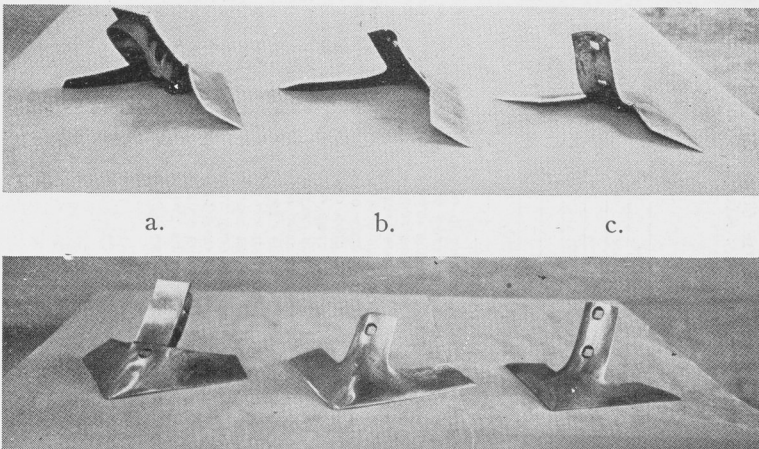


Fig. 5. High, medium and low pitch cultivator sweeps, (rear view, top; front view, bottom). The high pitch sweep shown at the left will throw more soil into the corn row to cover weeds but leaves more of a furrow than the low pitch sweep shown at the right.

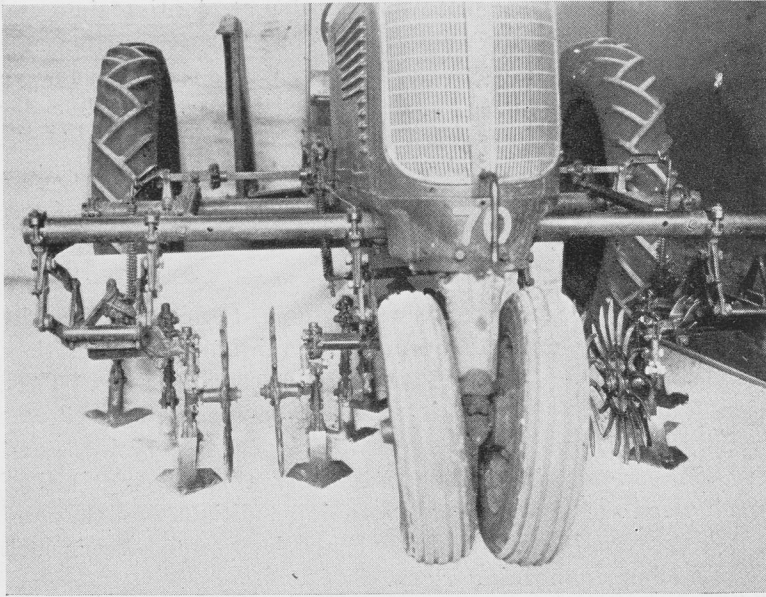


Fig. 6. The equipment found most satisfactory for cultivation when corn plants were small consisted of six full sweeps per row and rotary hoe shields. The rotary hoe wheels regulated more uniformly the amount of fine soil moved into the row to cover weeds, and they had less tendency to clog with moist soil or trash than the commonly used sheet steel shields.

planted corn in 1941. These results indicate that weed competition until the corn plants stood 8 to 10 inches high did not injure the corn provided that weeds could be destroyed at that stage of growth of the corn. It would not be considered safe practice to omit early cultivation, but it is suggested that unless there is danger of sand-blowing, early cultivation with the sweep cultivator may well be delayed until the corn plants have grown large enough to permit thorough coverage of weeds in the corn row, that is until the corn plants have grown about six leaves.

When early cultivation was by use of the weeder (method "b") or the rotary hoe (method "c") yields were reduced below those obtained by use of the cultivator (method "e") only in experiments 3 and 4 in 1935 when the soil surface was deeply crusted by intense rain and in experiment 13 in

1939 when the surface soil was very dry at planting time and there was no effective rainfall after planting until after first cultivation. Results obtained by use of the rotary hoe were practically equivalent to those obtained by use of the weeder in all experiments in which they were compared. Yields obtained by use of the rotary hoe were somewhat lower than those obtained by use of the weeder in 1935, but it is questionable if these yield differences are large enough to be significant.

The rotary hoe and the weeder were most effective when the soil was lightly crusted by moderate rainfall and when they were used just as the weed seedlings were coming up. They were not very effective in destroying weeds when the soil was heavily crusted nor when the soil surface was very loose and dry. These machines made practically a 100-percent kill of small weed seedlings under favorable conditions, but they did not destroy well-established weeds nor deep-rooted weeds such as cocklebur or morning glory.

Use of a spike tooth harrow for early cultivation produced as good control of weeds and as good yields as use of the weeder or rotary hoe except in 1937 when the harrow damaged stands enough to reduce yields. The spike tooth harrow is somewhat troublesome to use for corn cultivation because of its tendency to gather trash.

The experiments showed that under ordinary weather conditions and where deep-rooted weeds were not a problem, one or two early cultivations with weeder or rotary hoe controlled weeds as well and produced as good yields as one early cultivation with a sweep cultivator. Under unusually wet or unusually dry conditions, better results were obtained by first cultivation with the sweep cultivator. The weeder is a lighter weight, lower cost machine and was found to be somewhat more convenient to use than the rotary hoe. It is important to keep the teeth reasonably sharp on both rotary hoe and weeder. Weeder teeth wear dull quicker than rotary hoe teeth, but the weeder teeth can be repointed by grinding, and they can be replaced at lower cost than rotary hoe wheels.

The weeder and the rotary hoe are light draft machines. A

tractor large enough to operate a two-row cultivator will pull a six-row weeder or rotary hoe. With one of these machines in six-row width, corn can be cultivated quickly and with low input of labor and power. Their use is especially advantageous on drill-planted corn, because they do not have any tendency to ridge the rows.

CULTIVATOR EQUIPMENT

A few years ago cultivators were generally equipped with straight or twisted shovels 3 to 6 inches wide. More recently spearhead shovels 5 to 6 inches wide have been used extensively. Sweeps 6 to 12 inches wide are generally used in some localities. Sweeps are made not only in different widths but also with sweep blades set at different vertical angles, as illustrated in fig. 5. A steep pitch sweep such as "a" in fig. 5 will throw more soil into the corn row than a low pitch or high speed sweep such as "c" in fig. 5. The high speed sweep makes a smaller furrow. Disk hillers are available for tractor cultivators, and they are used by a good many farmers in some localities, especially where corn is drill planted.

In the experimental work at Ames, sweeps and disk hillers have been found preferable to shovels under most conditions. Sweep cuts overlap which insures that all weeds in the space between corn rows will be uprooted or sheared off without deep cultivation. Sweeps can be used that will throw sufficient soil to cover ordinary weed growth in the corn row at the first cultivation, but sweeps do not ridge the rows so much nor throw soil so high as shovels do; therefore they have less tendency to cover small corn plants. Pointed shovels penetrate hard ground better than disks or sweeps do. For use of either sweeps or disk hillers, there should be sufficient weight or means of applying pressure to the cultivator beams to force the sweeps or disks to the proper depth in the soil under all conditions. Disk hillers cause heavy side thrusts on cultivator beams and therefore require rigid beam construction.

The equipment found most satisfactory for first cultivation when corn plants were small is shown in figs. 6 and 7. It

consists of six full sweeps per row and rotary hoe shields. The rotary hoe wheels regulated more uniformly the amount of fine soil moved into the row to cover weeds, and they had

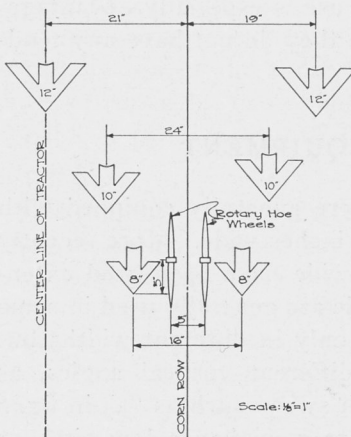


Fig. 7. Dimensions of adjustments for 42" rows of equipment shown in fig. 6. Some changes in adjustments may be desirable to suit various conditions.

less tendency to clog with moist soil or trash than the commonly used sheet-steel shields. It was found important to have the rotary hoe wheels set in the correct position. The center of these wheels should be about 4 to 6 inches back of the points of the front sweeps, and the wheels should run deep enough to insure continuous rotation. Dimensions of the proper adjustment for 42-inch row spacing are shown in fig. 7. Sweeps and rotary hoe shields as described above were used and found satisfactory for first cultivation of corn at various

stages of growth from the time when it first came up until the plants had 4 to 6 leaves.

When first cultivation could be delayed until the corn plants had reached the six-leaf stage of growth, better coverage of weeds in the corn row was obtained by leaving off the rotary hoe shields and using half sweeps in front as shown in figs. 8 and 9.

For the second cultivation, sweeps may not throw enough soil to cover weeds in the corn row. Weeds were more thoroughly destroyed by replacing the front pair of sweeps with disk hillers. One pair of disk hillers adjusted to throw soil into the corn row and four sweeps per row as shown in figs. 10 and 11 were found to be the best equipment for second cultivation under ordinary conditions. The disk hillers were effective in covering weeds in the corn row without cutting deep enough in the soil or close enough to the row to cause

any serious injury to corn roots. Disks also have the advantage of not clogging with trash or with vine weeds.

Scrapers on the disks as shown in figs. 10, 11, 12 and 13 were made and used experimentally to prevent coverage of corn plants. Without the scrapers the disks may throw soil high enough to cover corn plants at the second cultivation; but, with the scrapers attached, the disks raise the soil only to the height at which the scrapers are set. By proper adjustment of the scrapers, disk hillers were used successfully in cultivating corn as small as 6 to 8 inches high.

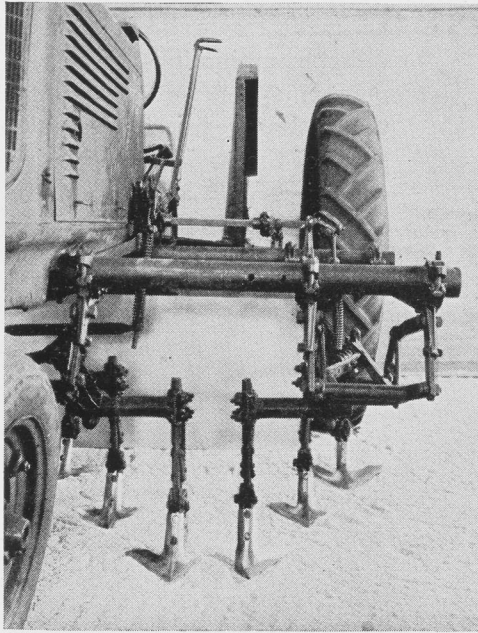


Fig. 8. When first cultivation could be delayed until the corn plants had grown six leaves, shields were not needed and half sweeps were preferred rather than full sweeps next to the corn row.

For weedy conditions and especially for destroying morning glories, the equipment shown in figs. 14 and 15 was most effective. It consists of two pairs of disk hillers and one pair of sweeps per row. The front pair of disks are set close to the row and throw soil away from the row. The second pair of disks throw soil into the corn row. The sweeps till the remaining space between rows. The leaf guards shown on the front pair of disks were useful when cultivating corn less than 8 to 10 inches high. Scrapers were used on the second pair of disks.

The equipment found to be most effective for the final cultivation is shown in fig. 16. It consists of one pair of disk hillers and two pairs of sweeps per row, the same as used for

second cultivation except that scrapers on the disks were not necessary.

The above described combinations and adjustments of cultivator sweeps and disk hillers were found most useful in experimental work at Ames. Other combinations or adjustments may be as good or better than those described under some of the various cultivating conditions that exist in different localities and under varying weather conditions.

Spring tooth weeder rear attachments for tractor cultivators as shown in figs. 17, 18, 19 and 20 were made and used experimentally. The attachment consists of weeder teeth set in lines diagonal to the corn row. The weeder teeth moved some of the loose top soil away from the corn row, filled tractor

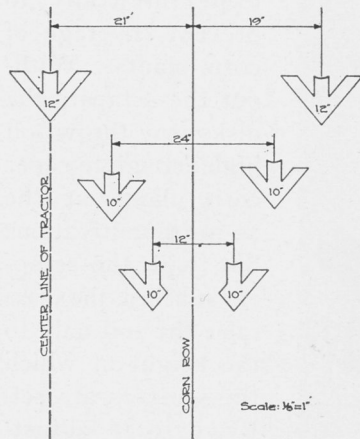


Fig. 9. Dimensions of adjustments for 42" rows of equipment shown in fig. 8. Different spacing of front sweeps may be desirable to suit various conditions.

wheel tracks and left the space between rows nearly level. The raking action of the weeder teeth also improved the kill of weeds between corn rows. A narrow ridge was left untouched by the weeder teeth on the corn row where soil had been thrown by the cultivator to cover weeds.

It was found desirable to change the tooth spacing on this attachment to suit various conditions. Where the soil was mellow and practically free of weeds or trash that would gather on the teeth, close spacing of teeth was necessary in order to move enough soil to fill tractor wheel tracks. Where trash or weeds gathered on the teeth, some of the teeth were removed to give wider spacing of the remaining teeth.

The use of this rear attachment was found advantageous for all cultivations. Leveling the space between rows by use of the weeder attachment was especially advantageous for drill-planted corn as it eliminated any furrow between rows

and thus made it easier to guide the tractor accurately at the next cultivation or at harvest. Ridging of rows is reduced, which is advantageous for both drilled and checked corn.

The scrapers and leaf guards for disk hillers and the spring-tooth weeder rear attachment described above were developed experimentally at Ames and, as far as we know, these items are not offered for sale by any manufacturer at the present time.

CULTIVATION OF CHECK-ROWED CORN

In the central part of the corn belt, corn is usually planted in check-rows so that it can be cross cultivated. The usual

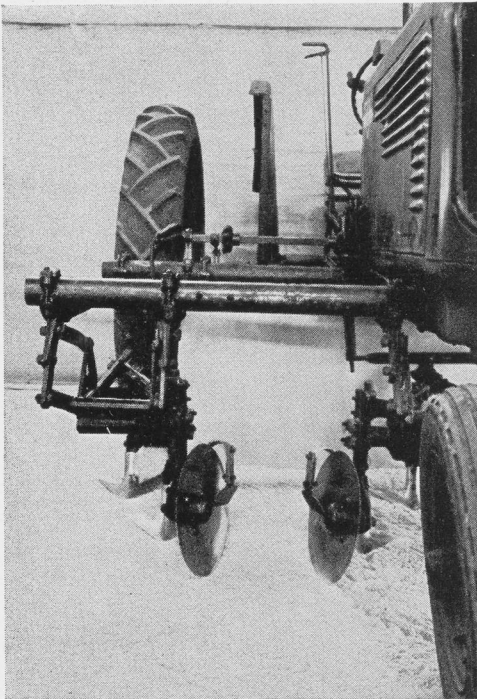


Fig. 10. For second and third cultivations, the equipment generally found most effective consisted of one pair of disk hillers throwing soil toward the corn row and two pairs of sweeps per row. Scrapers were used on the disks experimentally to prevent coverage of corn plants for the second cultivation.

practice is to give the corn three cultivations, the first and third in the direction of planting and the second crossways. Farmers in this area generally do a good job of controlling weeds in cornfields except when continuous wet weather prevents cultivation at the proper time. It has been observed, however, that in many cases the first cultivation is given when the corn is too small or with equipment that is not effective in killing all of the weeds in the corn row. The second or cross cultivation is then depended upon to kill weeds in

the rows. But, in case of unfavorable weather before second cultivation, the weeds may grow too large to be thoroughly destroyed with equipment that is commonly used.

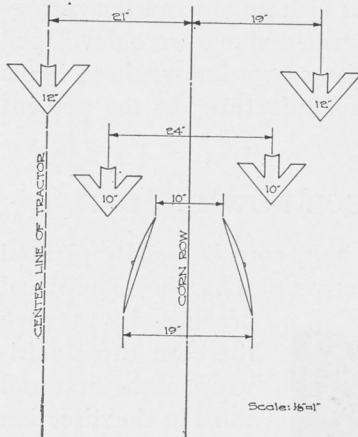


Fig. 11. Dimensions of adjustments for 42" rows of equipment shown in figs. 10 and 16. Different angles and spacing of disks may be desirable to suit various conditions. Scrapers (shown in figs. 10, 12 and 13) are usually desirable when this equipment is used for the second cultivation.

In the cultivation experiments reported above, using the cultivator equipment described in this bulletin, it was often possible to omit early cultivation and cultivate only twice without detriment to weed control or to yields of corn. This practice reduces the labor and power input in producing corn, but it cannot be recommended as there might be serious losses in weed control and in yields under extreme weather conditions. It is indicated, however, that with the best-adapted cultivator equipment weeds may be kept under good control even when

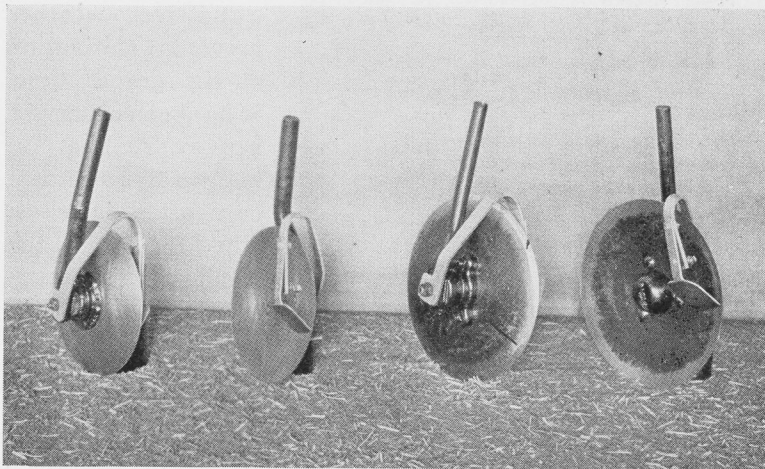


Fig. 12. Two makes of disk hillers showing construction of experimental scrapers.



Fig. 14. For cultivating weedy corn, two pairs of disk hillers and one pair of sweeps per row were good equipment. The front pair of disks were set close to the corn row and threw soil away from the corn. The second pair of disks threw soil into the corn row. Careful adjustment of the position of the disks as shown in fig. 15 was necessary.

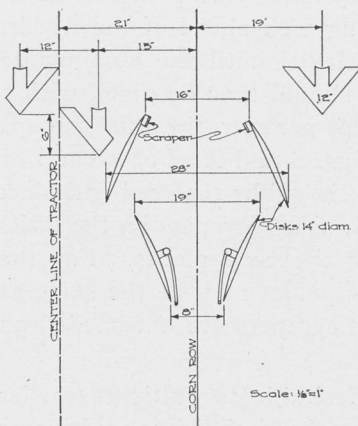


Fig. 15. Dimensions of adjustments used for 42" rows of equipment shown in fig. 14.

proper adjustments, this equipment can be used at any stage of growth of the corn from the time it first comes up until it has grown 4 to 6 leaves. The second and third cultivations should be carried on with the same equipment as suggested under (1).

(3) If a weeder or a rotary hoe of 4-row or 6-row width is available, some saving in cultivating costs can be made safely by use of one of these machines when conditions are favorable for its use. Under good conditions, one cultivation

with weeder or rotary hoe when the corn plants have grown about four leaves may safely replace the first cultivation with cultivator. The corn grower should be prepared, however, to use the cultivator and not the weeder or rotary hoe if the soil has been heavily crusted by intense rainfall or if the surface soil is loose and dry due to lack of rain. The second and third cultivations may be carried on with the same equipment as suggested above under (1).

It is usually considered desirable to use a rear attachment on a tractor cultivator to eliminate tractor wheel tracks. The experimental spring tooth weeder rear attachment shown in figs. 17, 18, 19 and 20 can be recommended for this purpose if the cultivator sweeps are all located ahead of the rear tractor wheels. Rear attachments as made by cultivator manufacturers work satisfactorily for check-rowed corn, except that they generally leave a furrow in the space between rows.

CULTIVATION OF DRILL-PLANTED CORN

In some localities a good many farmers have recently adopted the practice of planting corn rows on contours for

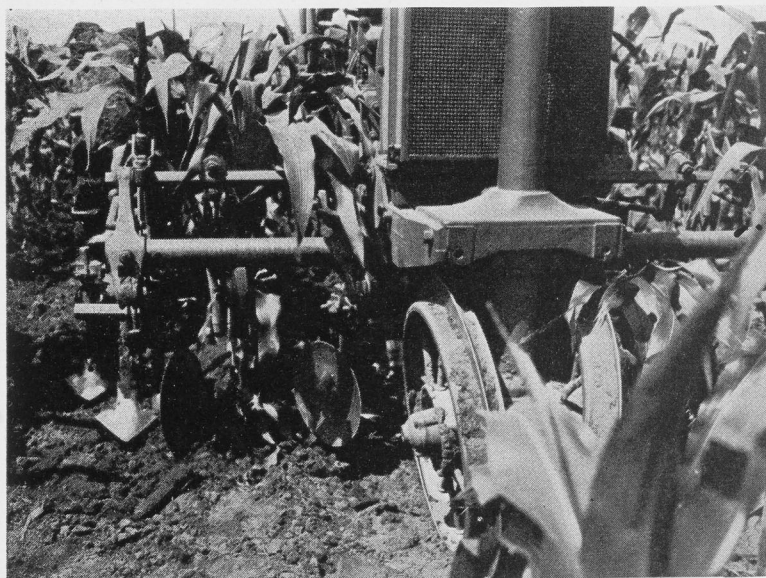


Fig. 16. Cultivator with one pair of disk hillers and two pairs of sweeps per row as used for last cultivation of corn.

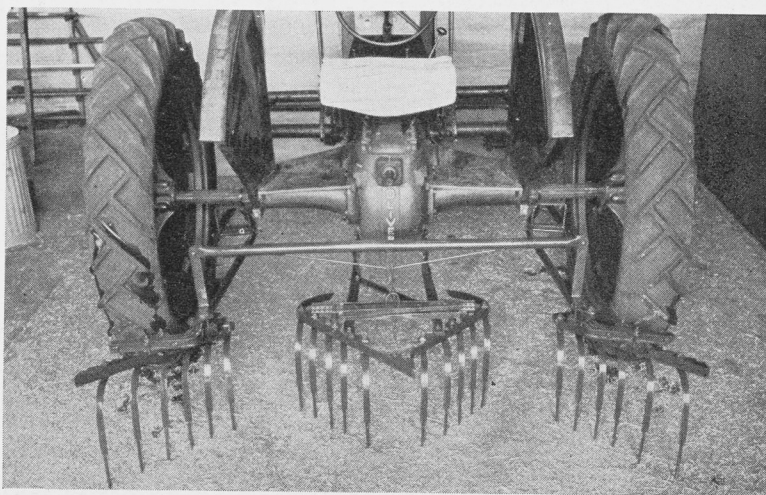


Fig. 17. An experimental spring tooth weeder rear attachment for a tractor cultivator was effective in filling tractor wheel tracks and leveling the space between rows. It also improved the kill of weeds by raking them to the surface. In this attachment, the center unit is lifted by a cross beam supported on the outside beams which are lifted with the rest of the cultivator.

purposes of soil and water conservation. Contour rows are drilled or hill dropped without check-rowing since contour rows are curved while check rows must be straight. Due to the fact that cultivation of drilled corn is all in the direction of planting, there has sometimes been difficulty in controlling weeds with cultivator equipment that has been in general use. There may also be an objectionable amount of ridging of the rows. These difficulties have been overcome by use of the best-adapted cultivator equipment.

The cultivating programs suggested for drilled corn when level-surface planted (that is, with no 'furrow openers used on planter) are as follows:

(1) Whenever conditions permit, use a weeder or a rotary hoe for the first cultivation. In addition to economy of operation, these machines have the advantage that they do not tend to ridge the rows. If the weeder or rotary hoe is used effectively when the corn plants have grown about four leaves, two subsequent cultivations with cultivator should be sufficient. The first of these cultivations usually will be about 10

days after the cultivation with weeder or rotary hoe. Rows should not be ridged any more than necessary at this time, but it is important to cover all weeds in the corn rows at this cultivation. One pair of disk hillers and two pairs of sweeps per row as shown in figs. 10 and 11 will usually be best, but if there are no large weeds in the corn rows, half sweeps in front as shown in figs. 8 and 9 may be preferred. For the last cultivation, one pair of disk hillers and two pairs of sweeps per row as shown in fig. 16 are the recommended equipment. A spring tooth weeder rear attachment such as shown in figs. 17, 18, 19 and 20 is recommended for all cultivations of drill-planted corn. It reduces ridging of the rows and also eliminates any furrow in the space between rows, thus making it easier to guide the tractor accurately at the next cultivation or at harvest.

(2) In case conditions are such that the weeder or rotary hoe cannot be used satisfactorily for first cultivation, a cultivator should be used with sweeps and rotary hoe shields as



Fig. 18. Experimental spring tooth weeder rear attachment for a tractor cultivator as used in the field. This picture shows also a grass seeder attachment for seeding clover at the last cultivation of corn.

shown in figs. 6 and 7 or with half sweeps in front as shown in figs. 8 and 9. In this case, it may be desirable to use the weeder or rotary hoe for the second cultivation. The rotary



Fig. 19. An experimental spring tooth weeder rear attachment in which the weeder units are attached directly to the beams of the standard rear attachment for the cultivator.

hoe can be used when the corn is about 10 inches high or the weeder when it is a little higher without serious damage to the corn plants. The weeder tends to level the ridges and furrows formed by the cultivator. If the weeder or rotary hoe cannot be used to advantage for the second cultivation, a cultivator with one pair of disk hillers and two pairs of sweeps per row as shown in figs. 10 and 11 may be used. For

the last cultivation one pair of disk hillers and two pairs of sweeps per row as shown in fig. 16 are recommended. There may be an objectionable amount of ridging of the rows if three cultivations are given with cultivator.

When drill-planting corn on contours, some farmers prefer to use disk furrow openers on the planter, as it is thought that the furrows assist in reducing run-off and erosion. Suggestions for cultivation are as follows:

(1) First cultivation should be with rotary hoe or weeder if conditions permit. A cultivator with half sweeps in front as shown in figs. 8 and 9 usually will be satisfactory for second cultivation. One pair of disk hillers and two pairs of sweeps per row as shown in fig. 16 may be used for the last cultivation.

(2) If it is desired to further reduce the amount of ridging of the rows, the first cultivation may be performed with a rotary hoe or a weeder and the second with a cultivator having one pair of disk hillers throwing soil away from the row and two pairs of sweeps per row as shown in fig. 22. The sweeps just behind the disks move enough soil into the corn row to cover weeds. This equipment moves a considerable volume of soil out into the space between rows where it will be picked up by disk hillers as shown in fig. 16 at the last cultivation, thus enabling the cultivator to move a large amount of soil and cover large weeds or grass in the corn rows at the last cultivation. Some farmers have found an advantage in staggering the disk hillers for last cultivation as shown in fig. 23 which shows a cultivator as used by Mr. W. C. Vigars, Eldora, Iowa, for last cultivation of corn drill-planted on contours. Soil thrown by the forward disk pushes weeds in the corn row down to the side, and the second disk completes covering them up.

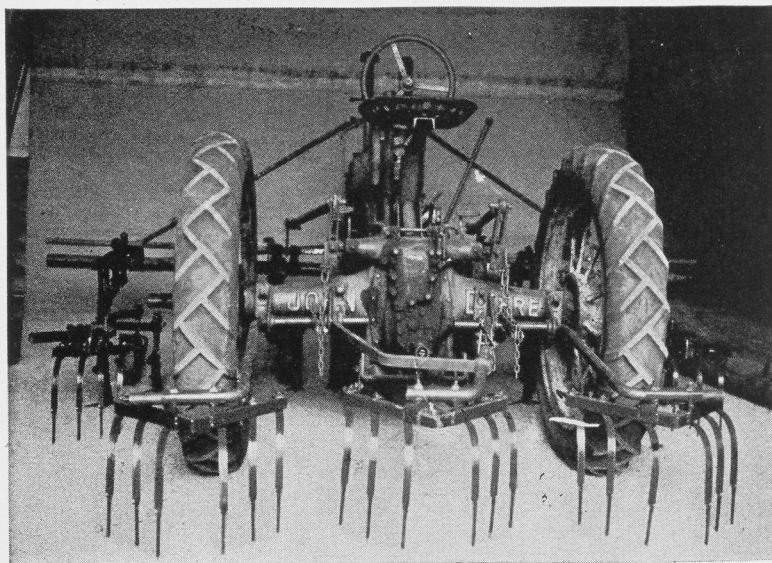
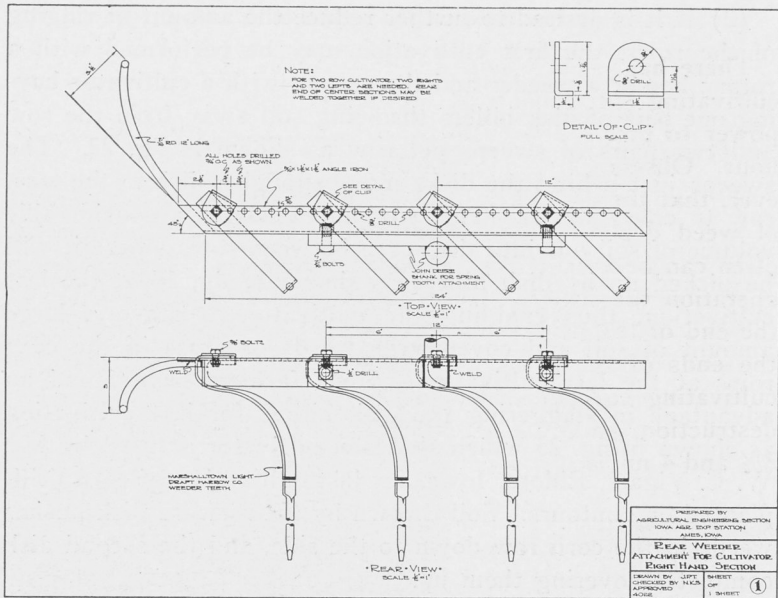


Fig. 20. Rear weeder attachment as used on a four-row cultivator set for 30" row spacing. The same arrangement would be practical for standard spacing. Weeder units are attached directly on the outer cultivator rigs.



CULTIVATOR SPEEDS

There has been a tendency to increase speeds of travel in cultivating since many of the row-crop tractors have ample power to propel the cultivator at speeds of 5 to 6 miles per hour. Observations made in these experiments indicate, however, that there is likely to be some sacrifice in effectiveness of weed destruction at high speeds. Cultivator equipment often can be adjusted to do good work at high speeds, but in operation the speed is usually reduced for turning around at the end of the field which may result in weedy conditions at the ends of the rows. The speed should be such that the cultivating equipment will do the best possible job of weed destruction, and this generally was observed to be between $2\frac{1}{2}$ and 4 miles per hour.

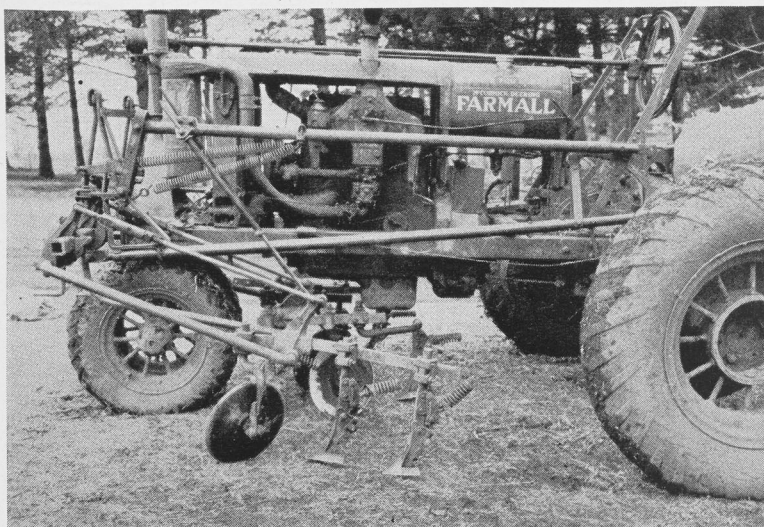


Fig. 23. For last cultivation, it may be desirable under some conditions to stagger the disks which throw soil into the corn row. This picture shows a cultivator as used for last cultivation by Mr. W. C. Vigers, Eldora, Iowa.

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